**Before the**
**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
| | ) | |
| Service Rules for Advanced Wireless Services In the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands | ) ) ) | WT Docket No. 04-356 |
| | ) | |
| Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands | ) ) | WT Docket No. 02-353 |

# REPLY COMMENTS OF MOTOROLA, INC.

Motorola, Inc. ("Motorola") hereby submits these reply comments in this proceeding to develop service rules for use of additional spectrum for advanced wireless services.[1] In these replies, Motorola provides test data on the ability of PCS handsets to "block" unwanted emissions originating in the so-called PCS H-Block at 1915-1920 MHz and comments on the ability of handsets to meet out-of-band emissions limits that are significantly greater than the FCC's existing standards. Finally, Motorola responds to comments that urge the Commission to delay this proceeding until completion of health-related research.

## 1. Receiver Blocking Measurements Support Limiting Transmit Power Levels.

In opening round comments, Motorola stated that it supported the use of the 1915-1920/1995-2000 MHz and the 2020-2025/2175-2180 MHz blocks for advanced wireless services and broadband personal communications services (PCS).[2] Motorola agreed with the Commission that stringent technical requirements related to power limitations and out-of-band

[1] Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands, *Notice of Proposed Rulemaking*, 19 FCC Rcd 19263 (2004) ("*NPRM*").

[2] Comment of Motorola, Inc., WT Docket No. 04-356, submitted December 8, 2004 (Motorola Comments).

emissions (OOBE) restrictions are necessary to protect incumbent licensees but concluded that, with certain additional safeguards and adjustments to the proposed rules, use of the subject frequency bands will have limited impact on adjacent band services.[3]

In particular, Motorola's analysis focused on the use of the 1915-1920 MHz band as expanded use of this spectrum raises concerns for receiver overload and intermodulation interference, where the main carrier from the 1915-1920 MHz device could interfere with PCS mobile receivers operating above 1930 MHz.[4] In this regard, Motorola noted that receiver overload interference is dependent on both the transmitting power of the interfering device and the ability of the victim receiver to block such energy.[5] Motorola concluded that an "interfering" transmitting device operating at 200 milliwatts – the FCC's proposed maximum output power – would be prevented from causing receiver overload interference into a mobile handset more than 1 meter away if the potential victim receiver has a blocking specification of at least -21 dBm.[6]

Attached to these comments as an Appendix is a report prepared by Motorola summarizing test results of the blocking performance of representative PCS handsets operating on various technology platforms. The method used by Motorola to determine blocking level is specified by the Alliance for Telecommunications Industry Solutions (ATIS) and Telecommunications Industry Association (TIA) standards and represents the device operating in a low signal level environment but without any injected noise.[7]

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[3] *Id.* at 2.

[4] *Id* at 4, 5.

[5] *Id.* at 5.

[6] *Id.*

[7] It should be noted that Motorola's test methodology differed from that employed by CTIA. The test procedure described in CTIA's comments injected noise into the device under

Motorola's test results show that, under certain conditions, the tested handsets are capable of meeting the minimum necessary blocking specification of –21 dBm to prevent overload interference at separation distances greater than 1 meter from a 200 mW mobile device. For example, Table 1 in the Appendix details the performance of a GSM handset that demonstrates the ability to block CDMA signals originating at 1917.5 MHz that are as high as –17.7 dBm when the victim receiver is tuned to 1930.2 MHz (the lower edge of the PCS A-block) and is operating at a reference sensitivity of –99 dBm. Even when desired signal level for the victim receiver is set to a lower value to approximate fringe coverage (in this case, 3 dB above the unit's measured sensitivity or –106 dBm) the unit still exceeds the –21 dBm threshold for interfering signals originating at 1917.5 MHz. However, when the interfering signal was set to 1918.75 MHz, this unit's blocking performance does degrade to –24.8 dBm. Under this low level operating condition, this unit might therefore suffer overload interference if it comes within approximately 1.5 meters of an interfering H-block transmitter operating at 1918.75 MHz.[8] The potential for interference would be greater if noise intended to simulate devices operating in a noise environment and to mimic systems operating under near capacity situations is injected during testing as was done for the CTIA tests.[9]

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test until the Frame Error Rate/Bit Error Rate (FER/BER) reaches a predetermined level. At that point, the blocking signal was injected until the FER/BER increased by 1 percent. *See* Comments of CTIA – The Wireless Association, Attachment A at 6 (CTIA Comments). CTIA performed this additional step to simulate devices operating in a noise environment and to mimic systems operating under near-capacity situations. In general, CTIA's results should show blocking at lower signal levels than Motorola's results.

[8] *Id.* at 6.

[9] *See* footnote 7 *supra*.

One potential solution to enhance the utility of the H-block spectrum is to vary transmit power by frequency. Data indicates that H-block transmit power levels could be set higher than 23 dBm for devices operating at frequencies below 1917.5 MHz. In the case of a 30 dBm handset transmitter, coexistence at 1 m separation with a victim receiver would require a blocking level of -14 dBm.[10] The GSM handsets tested by Motorola are able to achieve this performance for blocking signals that originate in the range of 1912.5 MHz to 1917.5 MHz.

**2. Out-Of-Band Emissions Levels Set By The Commission Should Be Consistent With Industry Standards.**

Motorola supports FCC adoption of OOBE limits consistent with levels currently specified by industry standards. In its opening comments, Motorola supported OOBE limits significantly lower than the current FCC requirement of –13 dBm/MHz for the bands above 1930 MHz. These emissions fall within the receiver pass band for current handsets operating on PCS frequencies and the only method to mitigate interference is to limit the emissions levels from nearby transmitters to levels that do not create unacceptable levels of interference.[11] Similarly, CTIA urged the FCC to adopt stringent OOBE limits of -74 to -76 dBm/MHz, which aligns with industry standards for CDMA technology.[12] In support of its proposals, CTIA provided measurements of handset OOBE using average detector measurements demonstrating that CDMA technology is well below the proposed OOBE limit while GSM devices produced emissions of -71 dBm/MHz and -76 dBm/MHz.[13]

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[10] Motorola Comments at A-1.

[11] *Id* at 7.

[12] CTIA Comments at 24.

[13] *Id.* at 71, Attachment B – WINLAB Report, PCS H Block Interference Tests.

Motorola notes that only four GSM devices were tested by CTIA and that two of those devices did not meet the OOBE limits proposed by CTIA. Based on this, it is apparent that changes would be necessary to GSM designs to meet the emissions levels proposed by CTIA. Motorola tested two of its current GSM architectures and found that neither would meet the proposed CTIA emissions levels. Figures 7 and 9 of the attached Appendix shows that the GSM specimens tested by Motorola have emissions levels of–78.74 dBm/100 Hz and –77.89 dBm/100 kHz at 20 MHz offset; when measured with a one megahertz bandwidth we find emissions at levels of –62 to –69 dBm/MHz for a 20 MHz offset (See Figure 10).[14] These measurements were taken at room temperature.[15]

Motorola is concerned that OOBE limits not be set below reasonable levels. In the US, GSM and CDMA devices have co-existed in these bands for some time at emissions levels specified by industry standards without widespread reports of interference. Because the addition of H-block reduces the guardband between transmitters and receivers to only 10 MHz, it is appropriate for the FCC to codify OOBE limits that align with current industry standards and practices to ensure that H-block licensees do not cause more interference than current PCS systems. While the emissions limits proposed by CTIA align with industry standards for CDMA, they greatly exceed industry standards for GSM. Further, some parties have proposed that any emissions limits applied to H-block should also apply to all PCS mobile devices in order to provide consistency in the rules and a level playing field for devices.[16] Specifying attenuation

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14 It should be noted that the handsets are allowed 5 measurements at a level of -36 dBm. *See* ATIS Standard T1.3GPP.05.05V8140-2003 at section 4.3.3.2.

15 Typically, handsets will perform better than the industry standards in such optimal conditions to ensure that performance meets the specified standard under all conditions of operation and variations of manufacturing.

16 *See, e.g.,* Comments of Nextel Communications at ii.

levels greater than that currently found in standards would require manufactures to redesign product portfolios and would result in increased cost, size and reduced talk times. This is clearly an undesirable impact. Accordingly, Motorola supports OOBE limits for GSM devices that are set no lower than in current industry standards. Thus, for GSM devices, a level of –71 dBm/100 kHz is appropriate with allowances for variations as permitted by the industry standards.[17]

### 3. The Commission Should Not Delay Action In This Proceeding On Radio Frequency Emissions Considerations.

Some parties in this proceeding have recommended that the Commission postpone its consideration of providing for new Advanced Wireless Services (AWS) service rules until the Commission implements "adequate safety precautions" or conducts "thorough and comprehensive research and study of the rule's impact on human health" or initiates a separate rulemaking "to adopt new, low-intensity RF exposure guidelines that are protective of public health."[18] Another party opposes adoption of the rules "because they do not protect school children from prolonged exposure to radio frequency radiation at high frequencies."[19] These comments lack scientific and legal merit and should not be the basis for Commission inaction in this proceeding.

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17 On a related matter, the Society of Broadcast Engineers argue that the OOBE emissions from AWS base stations operating at 2020-2025 MHz pose an interference threat to TV broadcast auxiliary operations in the 2025-2110 MHz band unless the FCC increases the proposed suppression limit from 43+10log(P) to a stricter requirement of 67+10log(p). Comments of the Society of Broadcast Engineers, Inc. at 1, 2. Based on current OOBE performance for mobile handsets, such a requirement would render the band unusable by W-CDMA technology and require the imposition of significant guard bands for other technologies (1.25 MHz for CDMA platforms and 1.5 MHz for GSM service).

18 *See, e.g.,* Comments of the American Skin Association at 1, Comments of Sage Associates at 1 and 3, Comments of The EMR Policy Institute at 1.

19 Comments of Protect Schools at 1.

Federal courts have repeatedly reaffirmed the adequacy of the Commission's carefully considered assessment of the potential health effects of RF energy and rejected similar petitioners' claims that there is evidence or need to initiate new proceedings on regulatory guidelines. In a decision made just two days before the initial comment deadline in this rulemaking, the U.S. Court of Appeals for the District of Columbia Circuit rejected the arguments and "studies" submitted by The EMR Network seeking exactly what The EMR Policy Institute seeks here, *i.e.*, a new rulemaking to revise RF safety regulations. The Court of Appeals concluded that "[w]e find nothing in those studies so strongly evidencing risk as to call into question the Commission's decision."[20] The Court also ruled that the Commission "appears not to have abdicated its responsibilities, but rather to have properly credited outside experts" such "federal agencies and their personnel who participate in its committees and subgroups" and the Institute of Electrical and Electronic Engineers (IEEE).[21] Finally, the D.C. Circuit Court, amplifying an observation of the U.S. Circuit Court of Appeals for the Second Circuit in its decision upholding the adequacy of FCC's RF exposure guidelines,[22] concluded that the Commission "has an adequate 'mechanism in place for accommodating changes in scientific knowledge'."[23]

The Commission is entrusted with a responsibility to monitor changes in scientific knowledge about the safety of RF fields and balance that knowledge with the need to protect the public and workers and enable deployment of wireless services for public benefit. The Commission is able to draw on the expertise of federal health agencies and a substantial

20 EMR Network v. FCC, U.S. Court of Appeals for the D.C. Circuit, No. 03-1336 at 7.

21 Id. at 6.

22 Cellular Phone Task Force v. FCC, 205F.3d 82 (2d Cir., 2000).

23 EMR Network v. FCC, at 6.

scientific database of epidemiological studies, lifetime animal bioassays, genotoxicity tests and other studies that have been regularly reviewed by independent expert groups, governmental panels and international standard-setting organizations. These expert review panels, as listed below, have consistently concluded there is no credible evidence that RF exposures within accepted international limits (i.e., standards published by the IEEE and guidelines developed by the International Commission on Non-Ionizing Radiation Protection) cause adverse health effects in humans and therefore compliance with existing standards sufficiently protects public health.

- World Health Organization International EMF Project (1998, 2000, 2004)
- International Radiation Protection Agency (1993)
- International Commission on Non-Ionizing Radiation Protection (1996, 1998, 2004)
- Royal Society of Canada Expert Panel (1999 and 2000)
- British Medical Association Board of Science and Education (2001)
- UK National Radiological Protection Board, including its Advisory Group on Non-Ionizing Radiation (1993, 1999, 2004)
- UK Independent Expert Group on Mobile Phones (2000)
- UK Institution of Electrical Engineers Policy Advisory Group on the Biological Effects of Low-level Electromagnetic Fields (2002, 2004)
- European Commission Expert Group (1996)
- French Department of Health Expert Group (2001, 2003)
- French Environmental Health and Safety Agency (2003)
- German Commission for Radiation Protection (2001)
- Health Council of the Netherlands (2000, 2002 and 2004)
- Norwegian Radiation Protection Authority (2003)
- Spanish Independent Expert Committee on Electromagnetic Fields and Public Health (2001)
- Swedish Council for Work Life Research (2000)
- Swedish Radiation Protection Authority (2002)
- Swedish Radiation Protection Authority Independent Expert Group (2003 and 2004)

With regard to children, there is also no scientific evidence of adverse health effects. The U.S. Food and Drug Administration (FDA) has twice addressed questions about children and RF exposure. As recently as January 13, 2005, the FDA concluded that "[w]ith regards to the safety and use of cell phones by children, the scientific evidence does not show a danger to users of wireless communications device including children."[24] This conclusion corresponds with the information provided in the joint FDA-FCC website, "Cell Phone Facts—Consumer Information on Wireless Phones," which states that "[t]he scientific evidence does not show a danger to users of wireless phones, including children and teenagers."[25] These conclusions also coincide with one recently published by the Health Council of the Netherlands that found "no reason to recommend limiting the use of mobile phones by children."[26]

In short, there is no reliable pertinent evidence in the initial comments of this proceeding that should prompt the Commission to question the adequacy of its RF exposure standards or their timely application to service rules for advanced wireless services.

**4. Conclusion.**

Making the 1915-1920/1995-2000 MHz band available for Broadband PCS use demands a careful balancing of the technical standards in order to provide interference protection to incumbent services. Motorola's analysis shows that in order to avoid overloading current PCS receivers, the maximum permitted power for transmitters operating in the 1915-1920 MHz band should be limited to less than the 33 dBm permitted for PCS devices in blocks A through G.

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[24] FDA Response to NRPB Report on Mobile Phones and Health – January 13, 2005, *available at* www.fda.gov/cellphones.

[25] Cell Phone Facts, Consumer Information on Wireless Phones, *available at* http://www.fda.gov/cellphones/qa.html#31.

[26] Electromagnetic Fields Committee. "Mobile Phones and Children: Is Precaution Warranted?" *Bioelectromagnetics* 25 at 142 (2004).

Further, the establishment of appropriate OOBE limits for devices operating in the 1915-1920 MHz band will ensure minimal impact to existing operations. While limits should be set much lower than current FCC limits, Motorola urges the FCC to be cognizant of the adverse impact on deployed technologies if levels in excess of current industry standards are imposed in existing PCS bands. Finally, Motorola notes that expert review panels have consistently concluded there is no credible evidence that RF exposures within accepted international limits cause adverse health effects in humans and therefore compliance with existing standards sufficiently protects public health. Therefore, the Commission should reject those comments that urge delay pending the initiation of new studies to determine the impact of RF emissions on the public health.

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## APPENDIX – BLOCKING PERFORMANCE AND OUT-OF-BAND EMISSIONS MEASUREMENTS

This appendix presents receiver blocking performance and out-of-band measurement results from handsets based on GSM and CDMA.  The blocking performance is a measure of the ability of the receiver to receive a desired signal in the presence of a strong interfering signal on any frequency and is described by its blocking specification agreed in the standards development groups (*e.g.*, ATIS, TIA, 3GPP or 3GPP2).  This becomes an important specification when operating in an environment where strong signals could be encountered, such as the case in a mobile-to-mobile environment in a crowded public gathering where little isolation (path loss) is available.  The interfering transmitter may be on a different frequency from that of the receiver and may even be modulated in a different way than the victim receiver is designed to demodulate.  The blocking specification is a special case of the more general spurious response characteristic of a receiver.  In general, handsets perform significantly better than the blocking specifications developed by the standards organizations.  The out-of-band emissions (OOBE) levels are an important factor to understand since the emissions fall within the pass band of potential victim receivers.

The test setup for blocking performances is shown in Figure 1.  The Signal Generator is an Agilent E4438C ESG Vector Signal Generator, Agilent 8960 wireless test set and a CMU200 Rohde&Schwarz Universal Radio Communication Tester.  The method to determine blocking level is to increase the blocking signal level until the on-channel Bit Error Rate (BER) or Frame Error Rate (FER) criteria reads at the specified level found in the relevant technology standard. It should be noted that this approach differs from the method used by CTIA, in which they injected noise into the device under test until the FER/BER reads a predetermined level, at that point they injected the blocking signal until a FER/BER increased by 1%. CTIA performed this addition step to simulate devices operating in a noise environment and to mimic systems operating under near capacity situations.  In general, the CTIA results would show blocking at lower levels than found in the below data. Measurements presented here were performed at room temperature, as temperature increases the blocking performance will decrease.

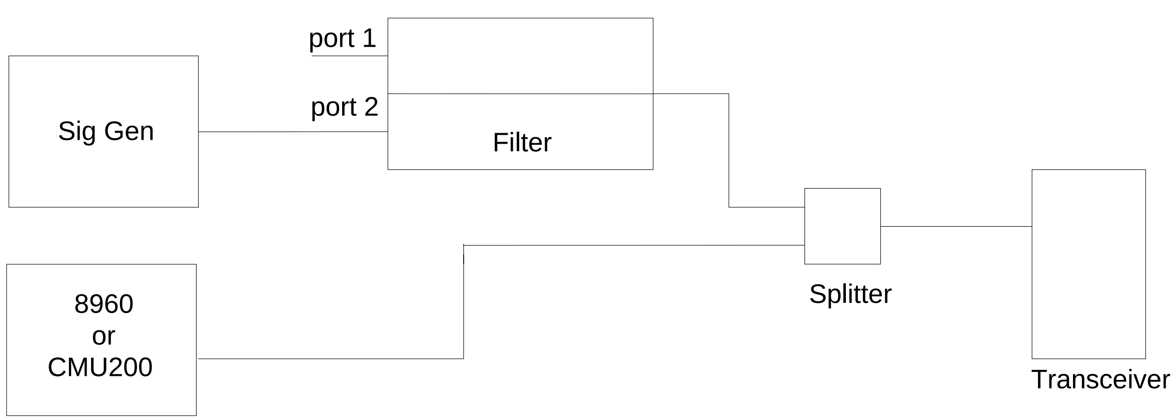


Figure 1. Measurement setup for blocking measurements

The system test box and the interferer are connected to the transceiver via a passive splitter. The interferer path incorporates a bandpass filter to attenuate the noise floor of the signal generator. The filter used is directional and includes two independent paths with each path incorporating two tuning elements. The filters are very narrow band and subject to detuning. Representative plots of the two filters are shown in Figure 2 and Figure 3.

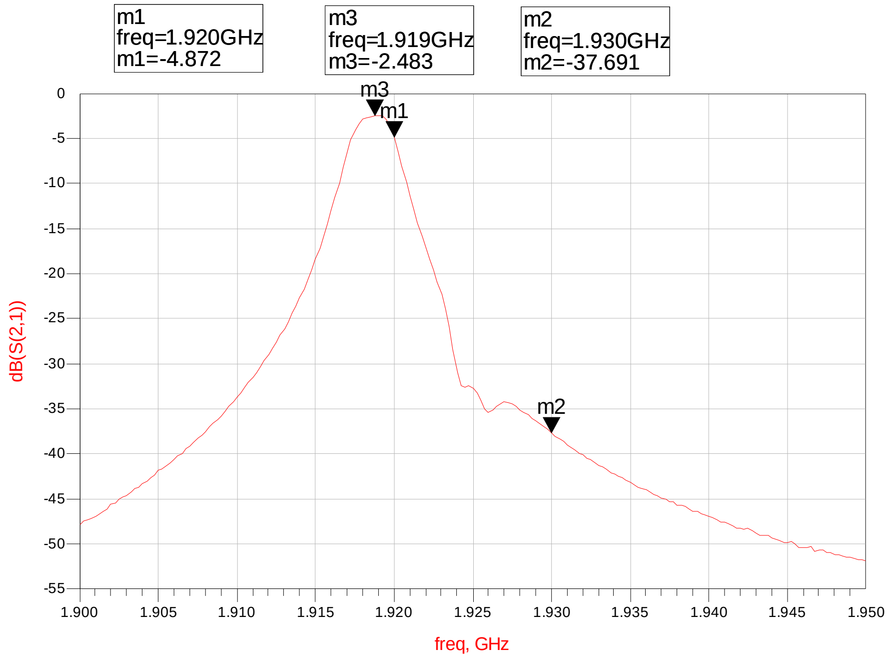


Figure 2: Filter path 1 tuned to 1919 MHz

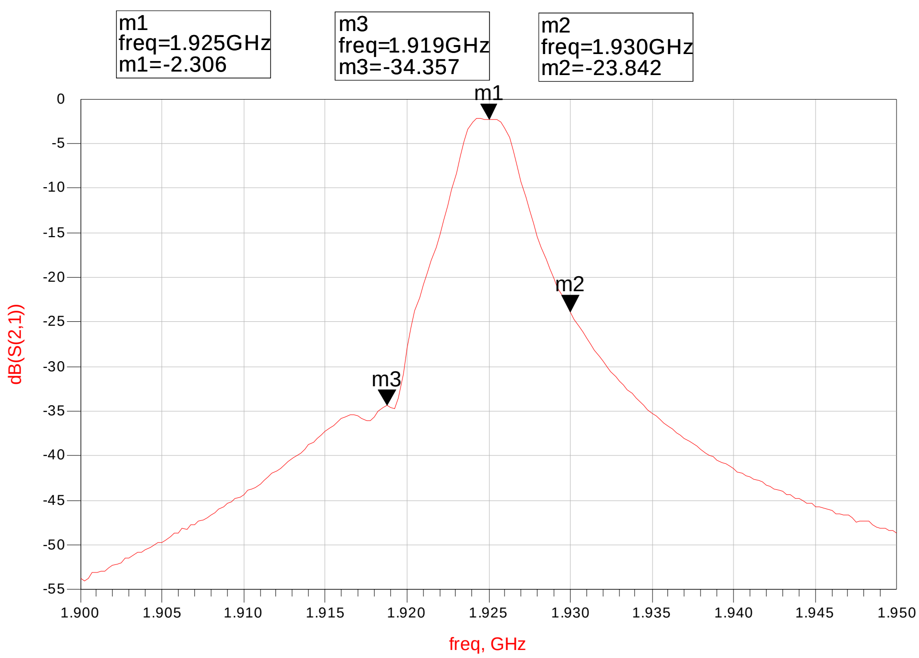


Figure 3: Filter path 2 tuned to 1925 MHz

## GSM Blocking Performance

Shown in Tables 1-5 are measurements performed on a specimen GSM handsets. The reference sensitivity was -102 dBm and the measured sensitivity of the handsets is -109.2 dBm for specimen 1 and -109 dBm for specimen 2. The blocking signal injected into the device under test was either a continuous sine wave signal (CW) or a CDMA modulated signal. The tests were performed with the desired signal level at 3 dB above the reference sensitivity (-99 dBm) and 3 dB above the measured sensitivity (-106 dBm). The blocking specification for this device is detailed in Project Alliance for Telecommunications Industry Solutions (ATIS) (3GPP) standard T1.3GPP.45.005V550-2003 at section 5.1 on blocking characteristics for frequency offsets of greater than 3 MHz. The on-channel blocking specification is a Bit Error Rate (BER) of 2%.

Table 1: GSM Specimen 1 blocker performance for handset tuned to 1930.2 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity +3 dB (-99 dBm) | 1925 | -5.2 | -17.4 | -21.7 | Measured sensitivity +3 dB (-106.2 dBm) | -26.8 | -29.5 |
| | 1920 | -10.2 | -13.2 | -20.3 | | -22.1 | -25.6 |
| | 1918.75 | -11.45 | -12.4 | -19 | | -20.3 | -24.8 |
| | 1917.5 | -12.7 | -11.0 | -17.7 | | -18.7 | -19.2 |
| | 1912.5 | -17.7 | -4.3 | -9.9 | | -11.2 | -12.2 |
| | 1911.25 | -18.95 | -3.8 | -5.3 | | -10.7 | -11.7 |
| | 1910 | -20.2 | -2.7 | -4.2 | | -9.6 | -10.6 |
| | 1905 | -25.2 | 2.4 | >-1.1 | | -4.6 | -5.6 |
| | 1900 | -30.2 | 5.8 | >-1.1 | | -1.1 | -2.1 |
| | 1850 | -80.2 | >6.3 | >-1.1 | | >6.5 | >-1 |

Table 2: GSM Specimen 1 blocker performance for handset tuned to 1950.2 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity +3 dB (-99 dBm) | 1925 | -5.2 | -13.9 | -21.2 | Measured sensitivity +3 dB (-106.2 dBm) | -22.8 | -27.8 |
| | 1920 | -10.2 | -11.7 | -19.8 | | -21.1 | -25.6 |
| | 1918.75 | -11.45 | -11.4 | -19 | | -19.8 | -24.8 |
| | 1917.5 | -12.7 | -10.0 | -17.7 | | -17.2 | -18.2 |
| | 1912.5 | -17.7 | -3.8 | -9.4 | | -10.7 | -11.7 |
| | 1911.25 | -18.95 | -3.3 | -4.8 | | -10.7 | -11.2 |
| | 1910 | -20.2 | -2.7 | -4.2 | | -9.7 | -10.7 |
| | 1905 | -25.2 | 2.9 | >-1.1 | | -4.1 | -5.7 |
| | 1900 | -30.2 | >6.3 | >-1.1 | | -0.6 | -1.6 |
| | 1850 | -80.2 | >6.3 | >-1.1 | | >6.5 | >-1 |

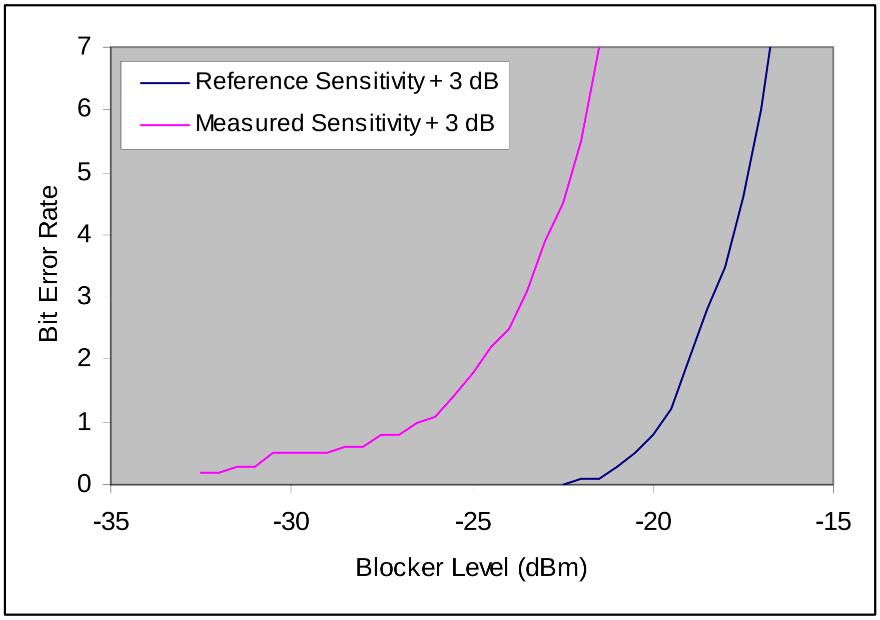


Figure 4: Specimen 1 bit error rate for CDMA blocker at 1918.75 MHz and handset tuned to 1930.2 MHz

Table 3: GSM Specimen 2 Blocker Performance for handset tuned to 1930.2 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity +3 dB (-99 dBm) | 1925 | -5.20 | -21.9 | -26.2 | Measured sensitivity +3 dB (-106 dBm) | -30.3 | -32.3 |
| | 1920 | -10.20 | -15.2 | -21.3 | | -21.6 | -26.1 |
| | 1918.75 | -11.45 | -12.9 | -19.5 | | -19.8 | -25.3 |
| | 1917.5 | -12.70 | -10.5 | -17.2 | | -16.7 | -18.7 |
| | 1912.5 | -17.70 | 0.2 | -6.3 | | -5.2 | -8.2 |
| | 1911.25 | -18.95 | 3.2 | >-1.1 | | -2.2 | -4.2 |
| | 1910 | -20.20 | 4.3 | >-1.1 | | -1.1 | -3.1 |
| | 1905 | -25.20 | 2.9 | >-1.1 | | -3.1 | -4.6 |
| | 1900 | -30.20 | 2.8 | >-1.1 | | -2.6 | -4.1 |
| | 1850 | -80.20 | >6.3 | >-1.1 | | >6.5 | >-1 |

Table 4: GSM Specimen 2 Blocker Performance for handset tuned to 1950.2 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity +3 dB (-99 dBm) | 1925 | -5.20 | -14.9 | -22.7 | Measured sensitivity +3 dB (-106 dBm) | -20.3 | -28.3 |
| | 1920 | -10.20 | -11.7 | -19.8 | | -17.1 | -25.1 |
| | 1918.75 | -11.45 | -10.9 | -18 | | -16.3 | -24.3 |
| | 1917.5 | -12.70 | -9.0 | -16.2 | | -14.7 | -16.2 |
| | 1912.5 | -17.70 | 0.7 | -5.3 | | -4.7 | -7.7 |
| | 1911.25 | -18.95 | 3.2 | >-1.1 | | -3.2 | -3.7 |
| | 1910 | -20.20 | 4.8 | >-1.1 | | -0.1 | -2.6 |
| | 1905 | -25.20 | 3.4 | >-1.1 | | -2.6 | -4.6 |
| | 1900 | -30.20 | 3.3 | >-1.1 | | -2.1 | -4.1 |
| | 1850 | -80.20 | >6.3 | >-1.1 | | >6.5 | >-1 |

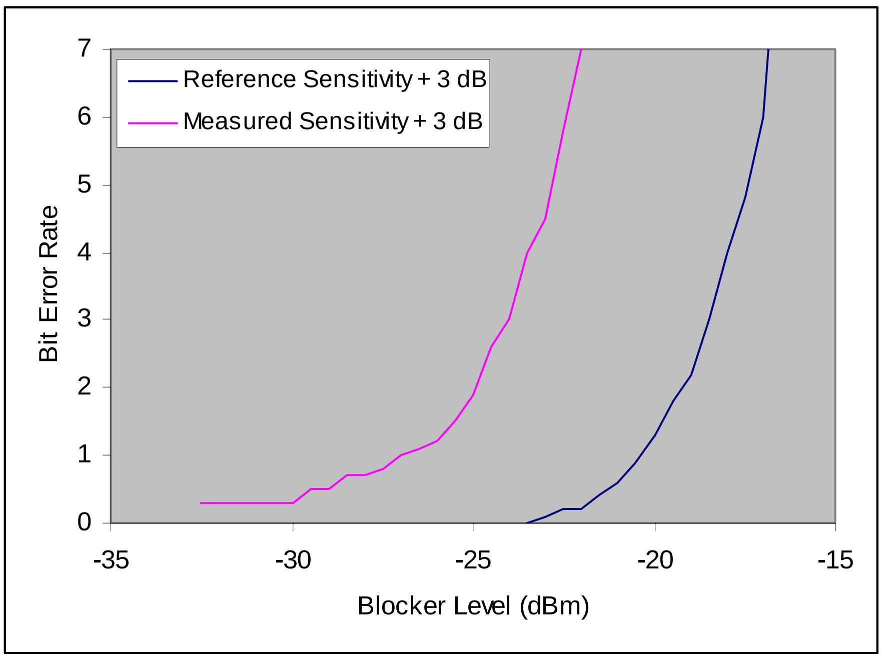


Figure 5: Specimen 2 bit error rate for CDMA blocker at 1918.75 MHz

## CDMA Blocking Performance

Shown in Tables 5-8 are measurements which were performed on a specimen CDMA handset. The reference sensitivity was -104 dBm and the measured sensitivity of the handset was -106.5 dBm. The blocking signal injected into the device under test was either a continuous sine wave signal (CW) or a CDMA modulated signal. The tests were performed with the desired signal level at reference sensitivity and 3 dB above the measured sensitivity. The on-channel blocking specification for this device is a Frame Error Rate (FER) of 1%.[1]

Table 5: CDMA Specimen Blocker Performance for handset tuned to 1931.25 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity + 3 dB (-101 dBm) | 1925 | -6.25 | -17.0 | -21.5 | Measured sensitivity +3 dB (-103.5 dBm) | -19.5 | -23.0 |
| | 1920 | -11.25 | -7.0 | -10.0 | | -9.0 | -12.0 |
| | 1918.75 | -12.50 | 4.0 | -3.0 | | 0.0 | -5.0 |
| | 1917.5 | -13.75 | >13.5 | 11 | | >13.5 | 1.0 |
| | 1912.5 | -18.75 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1911.25 | -20.00 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1910 | -21.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1905 | -26.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1900 | -31.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1850 | -81.25 | >13.5 | >13.5 | | >13.5 | >13.5 |

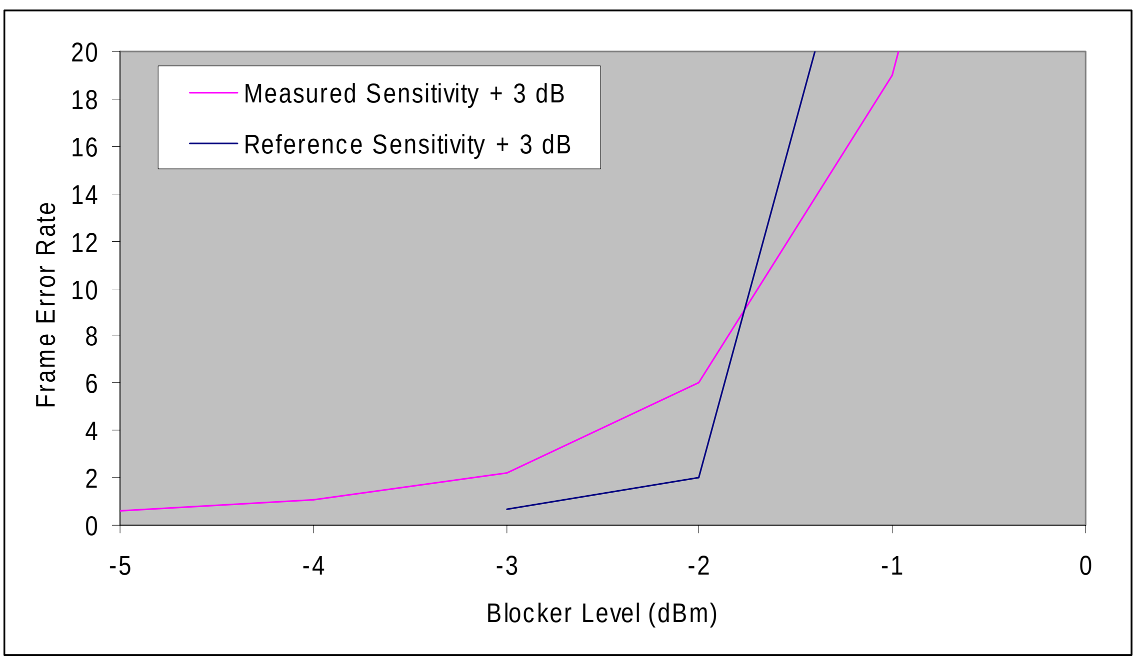


Figure 6: Bit error rate for CDMA blocker at 1918.75 MHz

1 TIA/EIA Standard TIA-98-F at section 3.5.2.3.

Table 6: CDMA Specimen Blocker Performance for handset tuned to 1966.25 MHz

| Reference level | Blocker | | Blocker level (dBm) | | Reference level | Blocker level (dBm) | |
|---|---|---|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA | | CW | CDMA |
| Reference sensitivity + 3 dB (-101 dBm) | 1925 | -41.25 | -12.0 | -20.0 | Measured sensitivity +3 dB (-103.5 dBm) | -11.0 | -19.0 |
| | 1920 | -46.25 | 0.0 | -9.0 | | >13.5 | 4.0 |
| | 1918.75 | -47.50 | 13.5 | 9.0 | | >13.5 | >13.5 |
| | 1917.5 | -48.75 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1912.5 | -53.75 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1911.25 | -55.00 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1910 | -56.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1905 | -61.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1900 | -66.25 | >13.5 | >13.5 | | >13.5 | >13.5 |
| | 1850 | -116.25 | >13.5 | >13.5 | | >13.5 | >13.5 |

Intermodulation tests were performed with the handset tuned to 1958.75 MHz and the transmitter at a power level of 24 dBm, CW and CDMA signals are at injected at 1918.75 MHz and 1998.75 MHz, results are shown in Table 7.

Table 7: CDMA Specimen Blocker Performance for handset tuned to 1958.75 MHz

| Reference level | Blocker | | Blocker level (dBm) | |
|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA |
| Reference sensitivity (-101 dBm) | 1918.75 | -40 | -11 | -13 |
| | 1998.75 | 40 | -16 | -19 |

Table 8 shows measurement blocking results of a specimen handset when the measurement is performed without the use of the bandpass filter.

Table 8: CDMA Specimen Blocker Performance for handset tuned to 1931.25 MHz (without signal generator filter)

| Reference level | Blocker | | Blocker level (dBm) | |
|---|---|---|---|---|
| | Freq (MHz) | Offset (MHz) | CW | CDMA |
| Reference sensitivity (-101 dBm) | 1925 | -5.65 | -21.5 | -28.0 |
| | 1920 | -10.65 | -18.0 | -28.0 |
| | 1918.75 | -11.25 | -17.0 | -28.0 |
| | 1915 | -15.65 | -13.0 | -29.0 |
| | 1910 | -20.65 | -12.5 | -32.0 |
| | 1905 | -25.65 | -12.0 | -32.0 |

**Transmitter out-of-band emissions levels**

Shown below in Figures 7-10 are the OOBE measured from two specimen GSM handsets, each specimen represents different GSM architectures from Motorola. This measurement was performed to determine the out-of-band emission level from current state of the art GSM mobile devices. The transmit power for the device was 30 dBm and the device center frequency is set to 1909.8 MHz. Measurements were averaged over the active part of the burst and were performed using the average measurements requirements specified in T1.3GPP.05.05V8140-2003.[2]

In Figure 7 marker "1" indicates the measured out-of-band power at 1930 MHz at a level of -78.74 dBm in a 100 kHz measurement bandwidth. At frequencies below about 1924 MHz the effects of a bandbass transmit filter is shown in the figure.[3]

Shown in Figure 8 is a measurement of the same specimen with a notch filter[4], this measurement was performed to estimate the OOBE at frequencies closer to the transmit center frequency. Marker 2 indicates the emission level at 10.2 MHz offset to be -72 dBm/100 kHz.

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[2] See 05T1.3GPP.05.05V8140-2003 at section 4.3.3.2 and section 4.2.1, relevant excerpts are:

**Section 4.3.3.2: Mobile Station GSM 700, GSM 850 and PCS 1 900**
The power emitted by the MS in a 100 kHz bandwidth using the measurement techniques for modulation and wide band noise (subclause 4.2.1) shall not exceed:
-79 dBm in the frequency band 869 MHz to 894 MHz;
-71 dBm in the frequency band 1 930 MHz to 1 990 MHz.

**Section 4.2.1: Spectrum due to the modulation and wide band noise.**
The specification applies to the entire of the relevant transmit band and up to 2 MHz either side. The specification shall be met under the following measurement conditions:
- for BTS up to 1800 kHz from the carrier and for MS in all cases:
- zero frequency scan, filter bandwidth and video bandwidth of 30 kHz up to 1800 kHz from the carrier and 100 kHz at 1800 kHz and above from the carrier, with averaging done over 50 % to 90 % of the useful part of the transmitted bursts, excluding the midamble, and then averaged over at least 200 such burst measurements. Above 1800 kHz from the carrier only measurements centred on 200 kHz multiples are taken with averaging over 50 bursts."

[3] The passband of the filter is approximately 1926 MHz to 1993 MHz. Emission levels outside this band are attenuated. Use of a filter is required so that the main carrier of the GSM signal does not influence the measurement of the OOBE.

[4] This notch filter attenuates the emissions in the 1907-1912 MHz to remove any influence the main carrier of the GSM signals during the measurement of OOBE.

Shown in Figure 9 and 10 are measurements with a specimen based on a different architecture than that measured in Figures 8 and 9. For the device tuned to 1909.8 MHz the measurement at 1930 MHz indicates the emissions level of -77.89 dBm/100 kHz. Another important aspect of the GSM standard is a limited number of spurs are allowed to exceed the -71 dBm/100 kHz requirement.[5] This exception can be seen by the spur near 1935 MHz which has a level of -65 dBm/100 kHz. Figure 10 is the same handset as measured with a 1 MHz bandwidth, in this case the measurement at 1930 MHz indicates a power level of -69.07 dBm/MHz. The spur at 1935 MHz is measured at a level of -62 dBm/MHz.

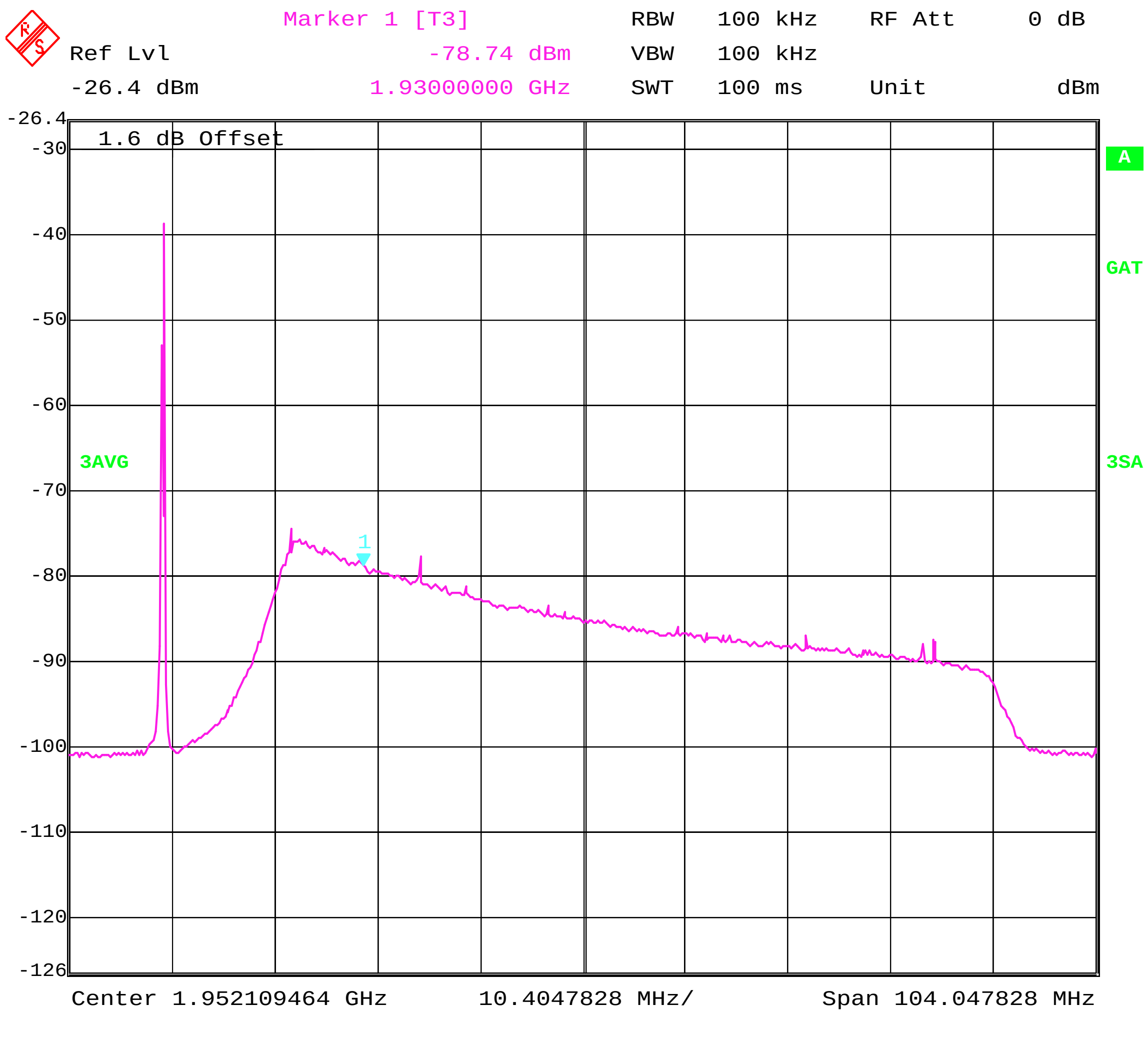


Figure 7. OOBE levels for specimen #1 GSM transmitter with center frequency at 1909.8 MHz (GSMK Modulation, bandpass filter)

5 *See* T1.3GPP.05.05V8140-2003 at section 4.3.3.2 ("A maximum of five exceptions with a level up to -36 dBm are permitted in each of the band 869 MHz to 894 MHz and 1 930 MHz to 1 990 MHz for each ARFCN used in the measurements.")

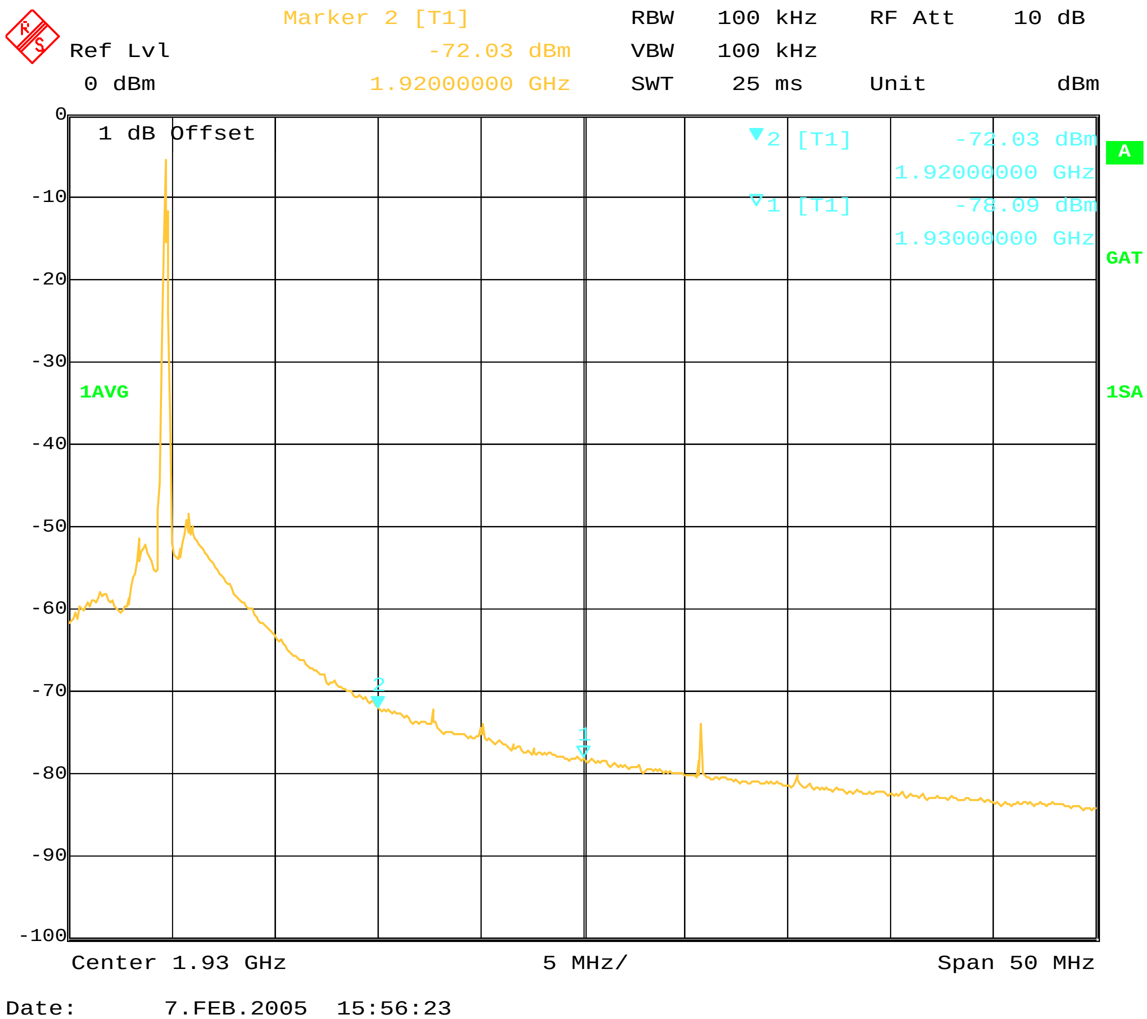


Figure 8. OOBE levels for specimen #1 GSM transmitter with center frequency at 1909.8 MHz (GSMK Modulation, tunable notch filter)

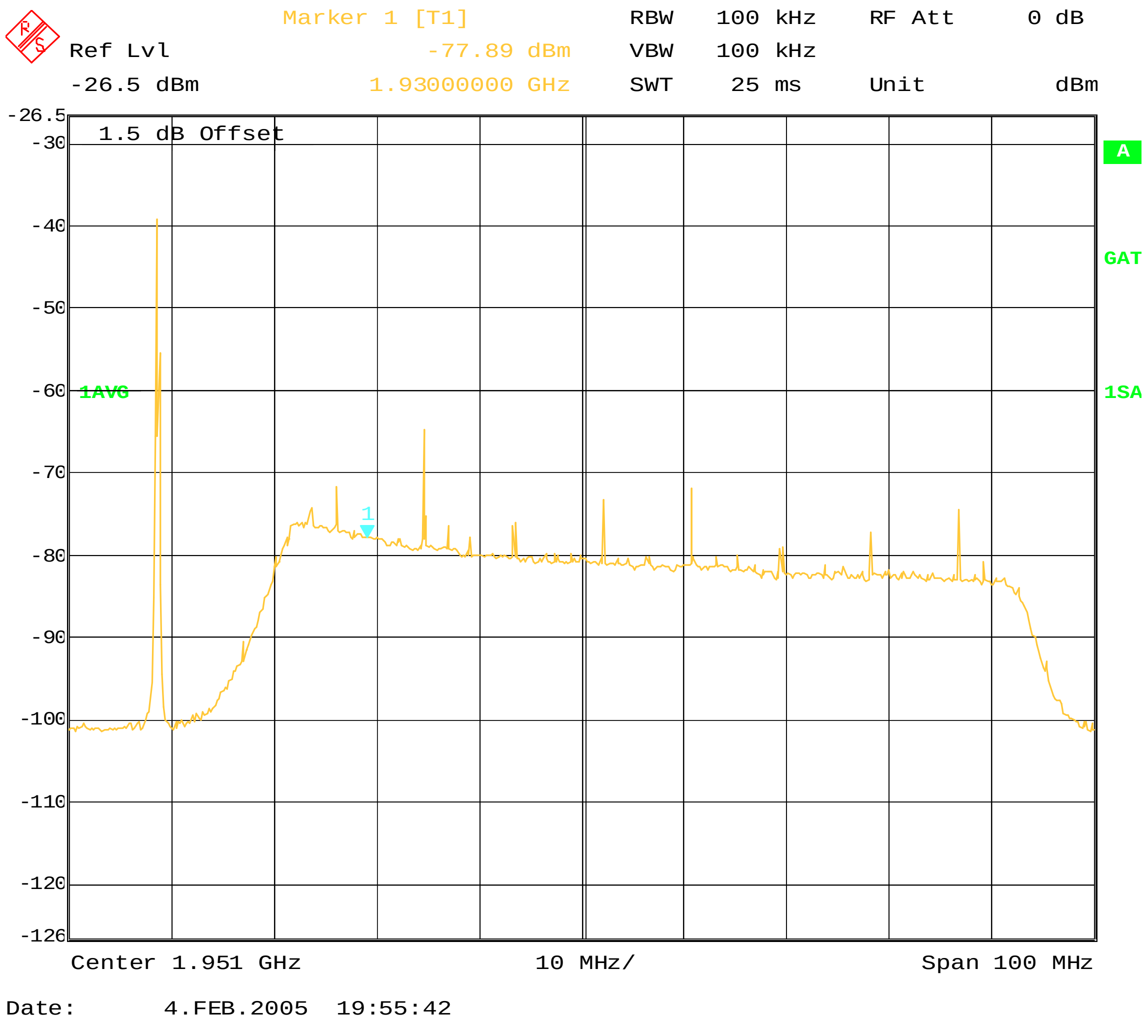


Figure 9. OOBE levels for specimen #2 GSM transmitter with center frequency at 1909.8 MHz (GSMK Modulation)

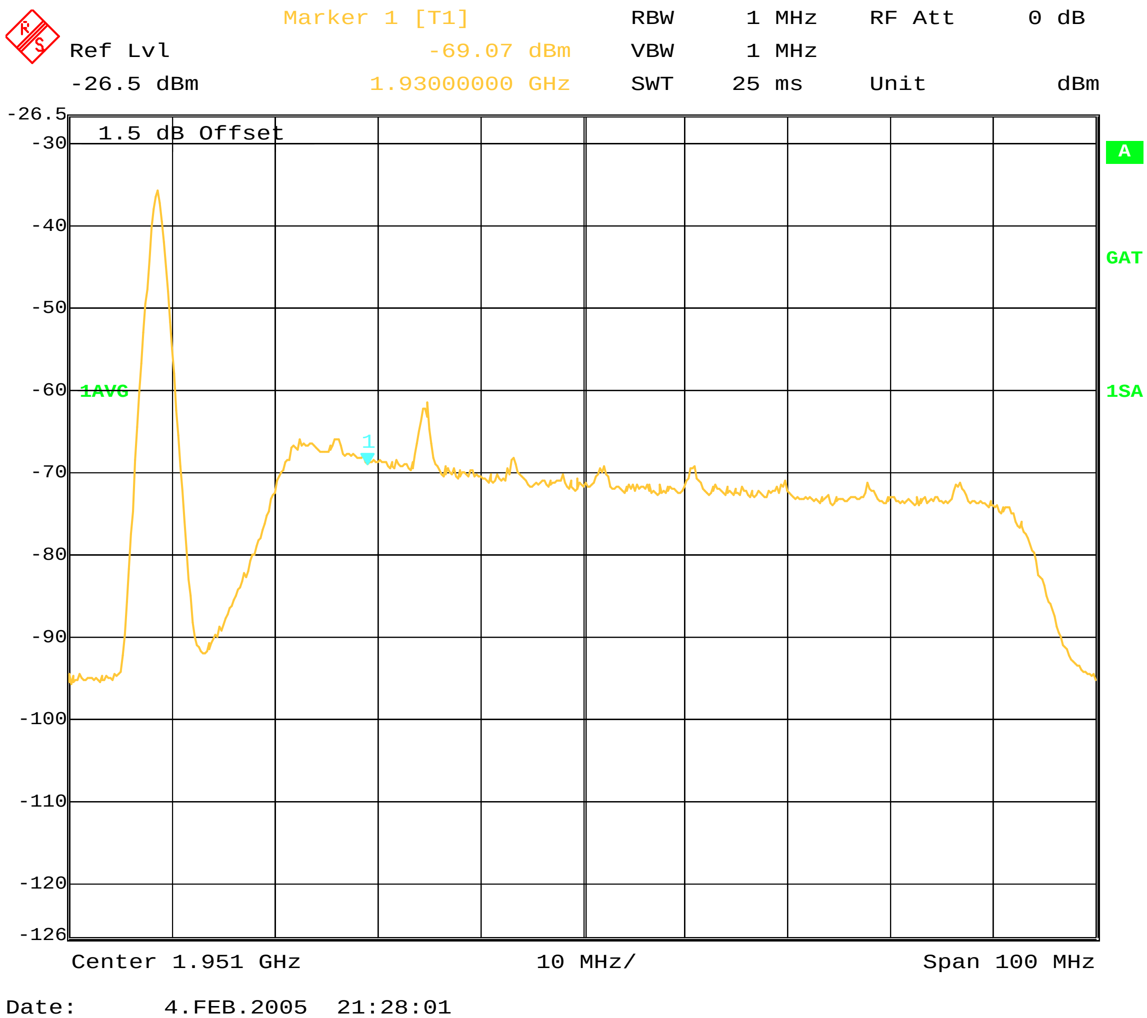


Figure 10. OOBE levels for specimen #2 GSM transmitter with center frequency at 1909.8 MHz (GSMK Modulation with 1 MHz measurement bandwidth)